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EDITORIAL

BOVINE MASTITIS

It is freely acknowledged that bovine mastitis is one of the diseases which influence considerably the milk output from individual cows, and therefore of the herds throughout a country. Much research work has been carried out, and is still in progress in different parts of the world: our knowledge concerning the causes and control of the disease has progressed considerably, and we are now in a position to adopt measures which, although they may not control the disease completely, are of such importance that their practice is followed by conspicuously good results. The literature on the causes and control of bovine mastitis is voluminous, and records the findings and observations of many workers throughout the world. It has been established that most outbreaks of mastitis are associated with the presence of micro-organisms in the excretion from the udder: the type of organism varies from outbreak to outbreak, and the symptoms of the disease often depend on the infection. It has been shown that, especially in the more chronic disease, the commonly associated organism is *Streptococcus agalactiæ*, and that this organism may be found in the secretions from apparently clinically healthy udders. Much work has been carried out on this organism, with the result that methods for the control of infection of the udder by it are now recognised. An important contribution, "Modes of Spread of *Streptococcus Agalactiæ* Infection in Dairy Herds,"* has recently been published; it consists of the findings of a group of observers working in different parts of this country, and shows that if this organism could be eliminated from the teats and udder of dairy cows the chances of reducing the incidence of mastitis would be very great. It has been recognised for a long time that the source of infection is the carrier cow or heifer; more exact methods of cultivation of

* "Modes of Spread of *Streptococcus Agalactiæ* Infection in Dairy Herds." A report on co-ordinated observations; organised by the Agricultural Research Council of the United Kingdom Imperial Bureau of Animal Health. Review Series, May, 1944, No. 2, Price 3s.

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the organism have shown that the carrier rate is high in an infected herd, and that if careful examinations are carried out over a long period the incidence of the carrier animals may be found to be very high. It is also pointed out in the article that *Str. agalactiæ* is commonly found on the hands of milkers and on various objects in the cowshed. An important part in the control of bovine mastitis, therefore, consists in the adoption of measures to lessen the chances of spread of the infection directly or indirectly from animal to animal.

Once infection has been established or clinical symptoms are in evidence, treatment becomes of importance. Many are the methods which have been used. An excellent description will be found in the article by Roach and Hignett, published in this issue of the VETERINARY JOURNAL. The methods used include the local application of medicaments by udder irrigation and the oral administration of various substances. Various workers record different results, and the various substances used have their keen supporters. Recently discovered compounds have been included, and have been applied in various forms of solution or emulsion. There is no doubt that some of the treatments have been followed by results of economic value, although it does not follow that in all treated animals a bacteriologically negative result has been obtained. In discussing treatment we must always consider the micro-organism with which we are dealing, for the same compound may have different results in the various types of infection.

The present position in the control of bovine mastitis seems to be that a considerable measure of success attends the adoption of measures to prevent the spread of micro-organisms associated with the disease from cow to cow, and the application of methods of treatment in known infected or carrier animals. The treatment of choice depends largely on the type of infection. The last word has not yet been said on treatment: work is still in progress, and we look forward to further information.

General Articles

THE ARTERIAL SYSTEM OF THE UDDER OF THE COW

By M. A. A. M. EL HAGRI, D.V.S.M.(Egypt), B.Sc., M.R.C.V.S.(Edin.)

(*Continued from page* 63)

PART I

The Arterial Blood Supply

In the cow, it is already established that the udder receives its blood supply from the mammary artery, which arises from the external pudental artery, which, in turn, comes from the pudendo-epigastric trunk. In this work, however, the subject was further investigated with the object of finding out whether or not other blood vessels contribute to the supply of the organ.

Material and Methods

After bleeding from the common carotid artery, a heifer, eighteen months old, was injected by the injection material described by Kellner (1934) for the preparation of a specimen prior to its dissection. In this case, however, 20 per cent. of glycerine was added to the given formula in order to retain the starch of the injection material in a fair state of suspension during the process of injection. The glycerine assists also the dehydration of the tissues and it seemed to help the injection material to settle in a more cohesive manner inside the blood vessels. About eight gallons of the injection material containing 10 per cent. formalin were used for this purpose. The injection was made under the force of gravity.

Results and Discussion

The results obtained from the dissection of the above injected specimen indicated that the udder received its blood supply from the following blood vessels, described in the order of their importance :—

1. The Mammary Artery

Ellenberger and Baum (1932) and Sisson (1941) described the origin, relations and course of this vessel to the udder. It was found that the mammary artery, as in the horse, has a common origin with the caudal epigastric artery from the pudendo-epigastric trunk. Its distribution in the udder will be dealt with at a later stage. It was, however, convenient to describe here the course of one of its branches, namely, the subcutaneous abdominal artery. Sisson mentions that a branch of the mammary artery accompanies the subcutaneous abdominal vein to the Xyphoid region. Turner (1933) stated that according to his observations and those of Zietschmann (1917), the subcutaneous abdominal artery might be given off as an anterior collateral branch of the mammary artery. Emmerson (1928) pointed out that this vessel formed a dorsal ramus of the cranial terminal branch of the mammary artery, which terminated on the ventral abdominal wall, cranial to the udder. In view of these observations and the little information at hand with regard to the origin and course of this vessel in the cow, the matter was further investigated. In three out of four X-ray films taken, in three out of five injected udders dissected, and in the celloidin preparation—all made for the study of the distribution of the mammary artery—the subcutaneous abdominal artery was absent. The vessel, however, was present in the injected

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specimen prepared for the study of the arterial blood supply of the organ. Accordingly, it could be stated that this vessel was present only in about 36 per cent. of all the specimens examined. When present, the vessel was found to take origin from the mammary artery as the latter entered the parenchyma of the organ. It ran in a cranial direction along the lateral part of the base of the udder in company with its satellite vein and ½ to 2 in. from the lateral border and ¼ to ½ in. deep to the dorsal surface. Usually midway along the lateral border, it terminated by dividing into lateral and medial basal branches, which were mainly distributed in the dorsal part of the base of the udder. (Photograph

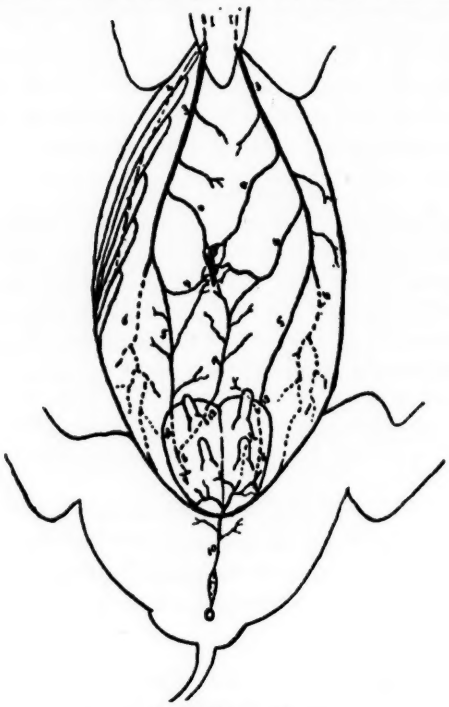

DIAGRAM No. 1.

The course and distribution of the subcutaneous abdominal and cranial epigastric arteries on the ventral abdominal wall.

1. Internal thoracic arteries.
2. Musculo-phrenic artery.
3. Cranial epigastric arteries.
4. Branches to umbilicus.
5. Mammary branches.
6. Deep branches anastomosing with caudal epigastric arteries.
7. Right medial basal branch.
8. Subcutaneous abdominal arteries.
9. Mammary arteries.
10. Perineal artery.
11. Perineal artery uniting with left lateral basal artery.
12. Right medial basal artery.
13. Lateral basal arteries.

No. 1.) In the abdominal region, the course of these terminal branches was followed. On each side of the udder, the lateral basal branch proceeded cranially in close association with the subcutaneous abdominal vein medially to the umbilical region, where it anastomosed with a subcutaneous or mammary branch from the cranial epigastric artery.

The collateral branches of the vessel in this region were directed cranially

PHOTOGRAPH No. 1.

X Ray photograph of the distribution of the mammary artery (left side).

1. Mammary artery.
2. Subcutaneous abdominal artery.
3. Branch to caudal lactiferous sinus.
4. Branch to cranial lactiferous sinus.
5. Medial basal branch.
6. Lateral basal branch.
7. Descending mammary artery.
8. Artery to caudal sulcus.
9. Superficial branch.
10. Deep branch.
11. Cranial terminal mammary artery.
12. Artery to lactiferous sinus.
13. Principal artery to anterior nipple.
14. Dorsal medial branch.
15. Medial mammary artery of Fürstenberg.
16. Lateral artery of anterior nipple.
17. Cranial mammary branch.

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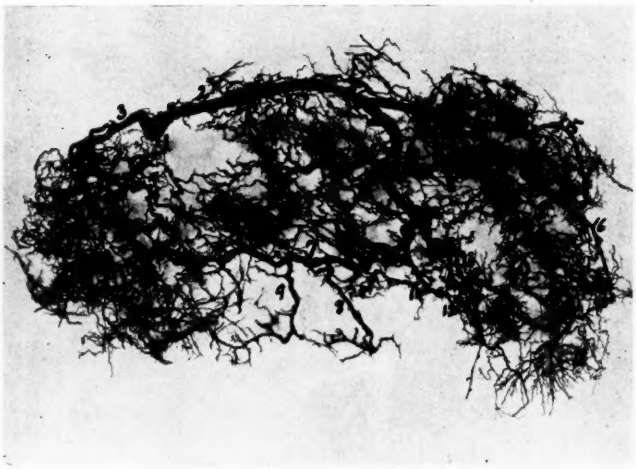

PHOTOGRAPH No. 2.

Celloidin cast of the mammary artery (right side).

1. Mammary artery.
2. Common basal branch.
3. Descending mammary branch.
4. Artery to caudal sulcus.
5. Artery to caudal lactiferous sinus.
6. Deep mammary artery.
7. Retrograde portion of deep mammary artery.
8. Principal artery to posterior nipple.
9. Lateral artery to posterior nipple.
10. Medial mammary artery of Fürstenberg.
11. Branch to both lactiferous sinuses.
12. Lateral artery to cranial lactiferous sinus.
13. Principal artery to anterior nipple.
14. Lateral artery to anterior nipple.
15. Medial basal artery.
16. Lateral basal artery

and medially over the abdominal tunic up to the umbilicus, similar branches of the mammary vessel of the cranial epigastric artery running in a caudal and medial direction, suggesting that union took place at the level of the umbilicus. (Diagram No. 1.) The medial basal branch of the right side only reached the umbilical region. This vessel, after leaving the cranial border of the udder close to the median plane, proceeded cranially and slightly towards the left, and terminated by several branches in that region. One of these branches, however, joined a branch from the left cranial epigastric artery before the latter vessel gave off the mammary branch to the corresponding lateral basal artery.

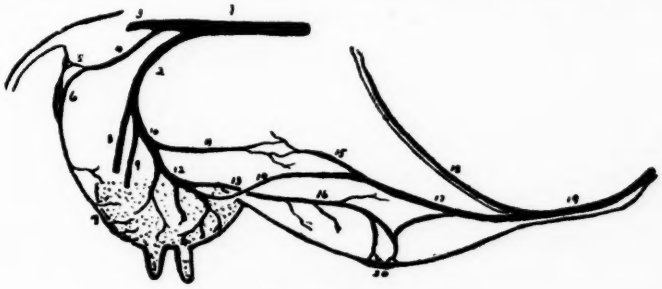

DIAGRAM No. 2.

Right lateral view showing the connection between the mammary and internal thoracic arteries.

1. Abdominal aorta.
2. External iliac artery.
3. Internal iliac artery.
4. Internal pudendal artery.
5. Branches to anal region.
6. Branch to vulva.
7. Perineal artery.
8. Femoral artery.
9. Deep femoral artery.
10. Pudendo-epigastric trunk.
11. Caudal epigastric artery.
12. Mammary artery.
13. Medial basal branch.
14. Lateral basal branch.
15. Deep branch of cranial epigastric artery.
16. Medial basal branch in abdominal region.
17. Cranial epigastric artery.
18. Musculo-phrenic artery.
19. External thoracic artery.
20. Umbilicus.

The medial basal branch on the left side did not extend beyond the cranial border of the udder. In some of the dissected specimens it was found that occasionally the medial basal branch joined the lateral basal branch of its own side, shortly before the latter appeared on the ventral abdominal wall. On the other hand, when the subcutaneous abdominal artery was absent, its place was taken by the common basal branch (cranial terminal branch of other authors) of the mammary artery situated at a deeper lever in every specimen examined. This latter vessel is referred to in this article as the common basal artery because of its constant disposition in relation to the base of the udder. In these cases, the lateral and medial basal branches of the subcutaneous abdominal artery were represented by the two dorsal terminal branches of the common basal artery, these being disposed in a like manner to the latter and medial basal vessels.

2. *The Internal Thoracic Artery*

In the same injected specimen, the course of this vessel was examined, but it is of interest only to describe one of its terminal branches, namely, the cranial epigastric artery. This latter vessel was seen to leave the thorax in the costo-sternal angle between the chondro-sternal extremity of the eighth sternal rib

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and the Xyphoid process of the sternum. The vessel lay down deeply under the rectus abdominis muscle. Receding from the chondro-sternal extremity of the ninth rib, the vessel proceeded caudally and medially in close company with the subcutaneous abdominal vein, and terminated in front of the umbilicus, about 5-7 in. lateral to it, by dividing into a deep or dorsal branch and a subcutaneous or mammary branch. The deep branch continued the course of the parent vessel in the substance of the rectus abdominis muscle and terminated by anastomosing with the caudal epigastric artery slightly caudal to the umbilicus. The subcutaneous or mammary branch pierced the rectus abdominis and the subcutaneous

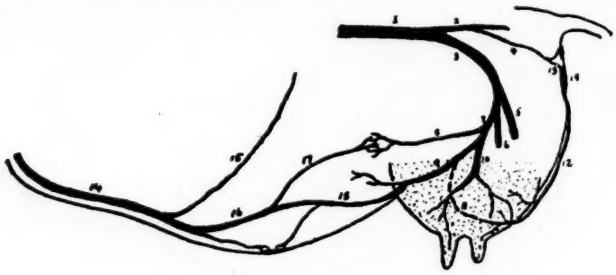

DIAGRAM No. 3.

Left lateral view showing the connection between the mammary and internal pudendal arteries.

1. Abdominal aorta.
2. Internal iliac artery.
3. External iliac artery.
4. Internal pudendal artery.
5. Femoral artery.
6. Deep femoral artery.
7. Pudendo-epigastric artery.
8. Caudal epigastric artery.
9. Subcutaneous abdominal artery.
10. Mammary artery.
11. Perineal artery uniting with subcutaneous abdominal artery.
12. Perineal artery.
13. Perineal branches to vulva and anal region.
14. Internal throacic artery.
15. Musculo-phrenic artery.
16. Cranial epigastric artery.
17. Deep branch.
18. Mammary branch uniting with subcutaneous abdominal artery.
19. Vulva.

muscles and appeared on the abdominal tunic under the skin. It then continued its course caudally and medially towards the umbilicus, becoming continuous with the lateral basal branch as already described. (Diagram No. 2.) This vessel thus represented the mammary branches of the internal thoracic (internal mammary) artery as it is found in man and dog, for example.

In view of this union between the internal thoracic and the subcutaneous abdominal artery, as well as between their venœ comitantes, the possibility of the spread of a blood-borne tuberculous infection from the thoracic region, where the disease in this form is prevalent among cows, may be considered.

3. The Internal Pudendal Artery.

According to Sisson, this vessel is the direct continuation of the internal iliac artery. It supplies the posterior uterine artery and then terminates as the artery of the clitoris, after supplying the bladder, vagina and rectum. However, he did not give a description of the perineal artery, a branch of the parent vessel, in the cow, although he represented this vessel as entering the caudo-dorsal part of the base of the udder, in diagrams 600 and 600a on page 728 of his text-book (" The Anatomy of Domestic Animals "). Ellenberger and Baum and Espé (1939) made similar representations of the perineal artery,

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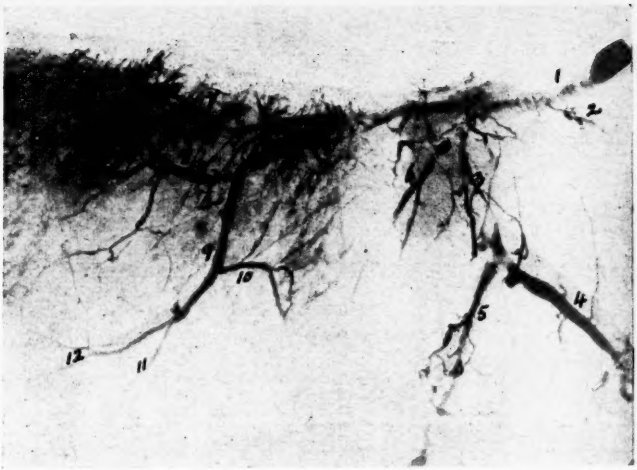
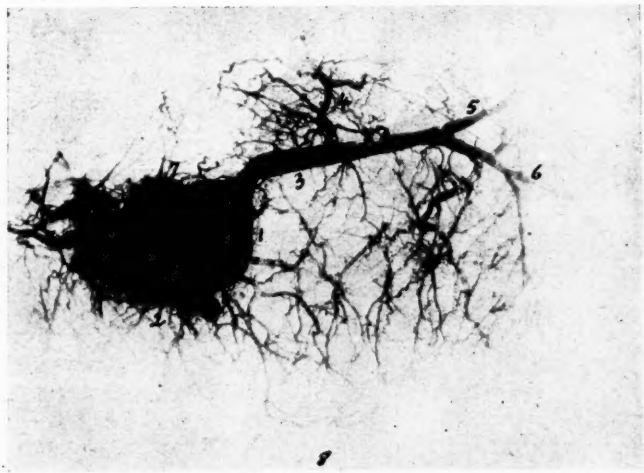


PHOTOGRAPH No. 3.

X-Ray photograph of the distribution of the mammery artery (left side).

1. Mammary artery.
2. Artery to supra-mammary lymph nodes.
3. Descending mammary artery.
4. Deep branch.
5. Superficial branch.
6. Artery to caudal lactiferous sinus.
7. Medial basal branch.
8. Lateral basal branch.
9. Artery to cranial lactiferous sinus.
10. Medial mammary artery of Füstenberg.
11. Principal artery to anterior nipple.
12. Lateral artery to anterior nipple.



PHOTOGRAPH No. 4.

X-Ray photograph of left common basal artery (dorsal view).

1. Mammary artery.
2. Superficial supra-mammary lymph node.
3. Common basal artery.
4. Artery to caudal lactiferous sinus.
5. Lateral basal branch.
6. Medial basal branch.
7. Descending mammary artery.
8. Median septum.

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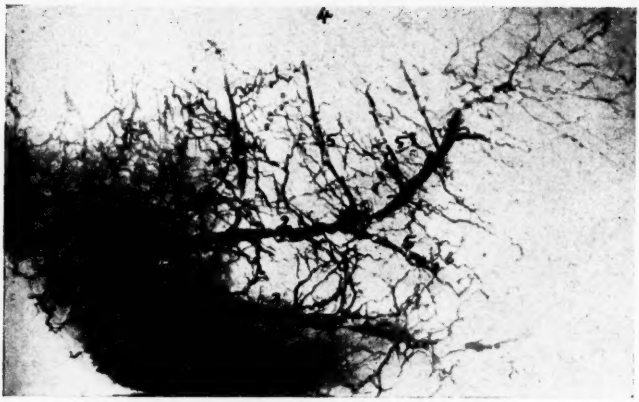

PHOTOGRAPH No. 5.

X-Ray photograph of right common basal artery (dorsal view).

1. Superficial supra-mammary lymph node.
2. Medial basal branch.
3. Lateral basal branch.
4. Median septum.
5. Parenchymal branches.

PHOTOGRAPH No. 6.

Ventral aspect of the right side of the Udder.

1. Posterior quarter.
2. Anterior quarter.
3. Principal artery of posterior nipple.
4. Principal artery of anterior nipple.
5. Lymph trunks of nipples.
6. Caudal branch of lateral artery of anterior nipple.
7. Inter-mammary sulcus.

but these authors did not speak of this vessel as contributing to the blood supply of any part of the udder. Therefore, it was important to follow the terminal course of this perineal artery, which was found to be as follows:—

The vessel appeared at the ventral commissure of the vulva after supplying the rectum. At first, it ran ventrally, then cranially, following the median rephe of the perineum under the skin. On reaching the caudal and ventral surfaces of the udder, it gave off several small twigs from both sides, which ramified on the facial investment of both posterior quarters, and none of these twigs were found to enter the parenchyma of the organ. The vessel then continued cranially, slightly to the left of the inter-mammary sulcus, and entered the deep parenchyma a short distance caudal to the base of the posterior nipple. In the parenchyma, the vessel inclined laterally in a cranial and dorsal direction, and joined the lateral basal branch of the subcutaneous abdominal artery. (Diagram No. 3.) There is no definite evidence, however, of the manner in which this vessel may terminate when the subcutaneous abdominal artery is absent; but it is probable that the artery either joins the lateral dorsal terminal branch of the common basal artery, which is identical with the lateral basal branch in its course and disposition, as already mentioned, or the artery to the caudal sulcus of the descending mammary artery (caudal or posterior terminal branch of other authors) which reaches the ventral part of the caudal sulcus. On examination of a celloidin cast of the distribution of the mammary artery, the subcutaneous abdominal artery was absent. The common basal artery gave off, before its termination, the deep mammary artery, which proceeded ventrally deep in the parenchyma, then turning caudally, it circumscribed an arch, the convexity of which was cranial, and continued caudally to the ventral part of the caudal sulcus. However, the specimen did show that the vessel did not terminate in that region. From the above, and taking into consideration the course of the perineal artery already described, it is suggestive that in this type of distribution of the mammary artery, the union between this retrograde portion of the latter vessel and the perineal artery takes place in that region.

After the preparation of this paper, Espé and Cannon (1943) reported the continued normal development of the udder of a heifer after the ligature of both external pudendal arteries. This suggests the presence of a supplementary arterial supply to the udder other than the previously-mentioned vessels, and is in line with the results given in this paper.

Summary

In addition to the mammary artery, other blood vessels were found contributing to the arterial supply of the udder.

In the injected specimen used for this study, these other vessels were the internal pudendal and internal thoracic arteries, which effected this contribution through their respective branches—the perineal and cranial epigastric arteries.

The three previously-mentioned vessels supplying the udder were united with each other by two anastomotic connections, one occurring at the level of the umbilicus between the subcutaneous abdominal and internal thoracic arteries, and the other, in the parenchyma of the organ between the subcutaneous abdominal and internal pudendal arteries.

The possible manner in which this anastomotic connection might occur in the absence of the subcutaneous abdominal artery has been discussed.

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PART II

The Arterial Blood Distribution

The literature on this subject shows marked diversity in the description of the distribution of the mammary artery in the udder. This study was carried out to give more information on this matter.

Material

Ten fresh udders were collected and utilised for obtaining the results of this investigation. One non-lactating udder was selected for the preparation of celloidin casts of the mammary artery and its branches. Four other udders were used for obtaining X-ray and stereoscopic films, and the remaining udders were injected by a colouring injection material prior to their dissection.

Methods

In addition to both X-ray and dissection methods used by previous workers, the celloidin injection corrosion method was utilised in the study of the distribution of the mammary artery in the udder.

Celloidin Injection Corrosion Method

This method is fully described by Hinman *et al.* (1923). However, certain practical points in its application for the purpose of this study must be mentioned.

On one side of the udder, the mammary artery was injected by a double injection of a solution of celloidin in acetone, treated with alkanin to impart a red colour to the solution. The first injection was made with 4 per cent. solution of celloidin (Scherring) under a pressure of 600 mm. of Hg for a period of 30 minutes. This was followed immediately by the second injection: 25 per cent. solution of discarded X-ray films in acetone, using a pressure of 400 mm. of Hg for a period of two hours. The second injection was then continued for 15 hours through the pressure bottle only, the latter being detached from the pressure apparatus. On the other side of the udder the mammary artery was injected in a similar manner. In addition, both the anterior and posterior quarters of the same side were injected through the teat canal with a solution of 3 per cent., followed by 25 per cent., solution of celloidin and discarded X-ray films respectively, no colouring material being used. A pressure of 200 mm. Hg was used for the first injection, which was maintained until each quarter was nearly filled. The second injection was then immediately made under a pressure of 150 mm. of Hg for a period of two hours. This latter injection was then continued overnight under the pressure from the pressure bottle. During the whole process, the udder was immersed under water and left there, after the end of the process, for three days to allow for the formation of the celloidin casts. After this period, digestion or corrosion of the soft tissues of the udder was effected by using concentrated HCL. The latter acid

has no effect on the celloidin casts, which remained behind unaffected. It was found that a non-lactating udder had to be selected when the parenchyma of the organ was injected. The reason was that any trace of milk in the quarter interfered with the obtaining of a successful celloidin preparation. This was evidenced by the failure attained after carrying out the injection in a lactating quarter from which the milk had been removed as far as possible.

Röntgenography and Stereography

This method is also described by Hinman *et al.* for demonstrating the circulation in general. Both mammary arteries were first flushed with normal saline solution until the venous return became clear. After this, the arteries were injected with a heavy suspension of 40 per cent. barium sulphate in 5 per cent. solution of sodium bromide in water. The specimens were then preserved in 10 per cent. formalin solution over a period during which a number of X-ray and stereoscopic films were taken.

Dissection Method

Kellner's (1934) method described in Part I of this work was also used for injecting the specimens prior to their dissection. In addition, all injected specimens used for X-ray examination were also dissected after the X-ray films were taken.

Results and Discussion

By using the celloidin injection corrosion method, two casts were obtained, one showing the mammary artery and its branches and the other the same in relation to the celloidin casts of both the anterior and posterior quarters. This latter specimen served the purpose of tracing the branches of the artery to their regions of distribution.

Espé (1939) stated that the mammary artery of one side might be connected with that of the opposite side. He mentioned also that X-ray photographs showed no connection existing between the branches of the main vessels of the same quarter, contrary to the suggestion made by some authors, whom he did not mention, that union between the branches of the main vessels of both quarters of the same side might even occur in spite of their independence automatically. Emmerson (1928) described one type of branching of the mammary artery in which the dorsal, dorsal middle and distal middle branches of the cranial terminal branch of the parent vessel were connected with each other. In the same type, the posterior branch of the cranial terminal branch was also connected with a branch of the caudal terminal branch of the parent vessel.

Examination of the celloidin cast of the mammary artery did not confirm any of the previous statements made by these workers. Therefore it is convenient to state here all the facts obtained from the study of the celloidin specimen :—

1. No connection between the mammary arteries of both sides could be found. This was substantiated by the fact that both celloidin casts obtained were freely separable from each other after the process of digestion of the soft tissues was completed. This statement, however, does not disagree with Espé's observation on this point. In two specimens only examined by dissection, the mammary arteries of both sides were found to be connected together. This connection was effected through the branches of the parent vessels supplying the supra-mammary group of lymph nodes. In these cases it was possible to inject freely both arteries at one time by applying the injection on one side only.

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2. The main branches of the mammary artery showed no anastomotic connections between them, contrary to what has been described by Emmerson.

3. Union between the branches of the main vessels of the mammary artery of either one or both quarters could not be seen. Examination of Photograph No. 2 of the celloidin preparation of the mammary artery may give a false impression of union existing between these branches. This is, however, due to the matting together of these branches in the specimen and not to their actual union. These facts were also confirmed by the findings obtained from X-ray photographs. Dissection by itself could not be considered dependable in its results, because the tracing of these small branches of the main vessels in the parenchyma was neither an easy nor an accurate process.

In this article it would be futile to state at length the various observations made by other workers on the distribution of the mammary artery. It is, however, reasonable to accept their description, which might have fitted well with the types of distribution they encountered. Accordingly, the description given in this work will be mainly based on the results obtained in the course of this study.

The celloidin preparation of the mammary artery presented a different picture from what has been previously described by other authors. Here, the subcutaneous abdominal artery was not represented as a collateral branch of the mammary artery. In this case and in other specimens examined by other methods, the mammary artery terminated after entering the base of the udder, by dividing into cranial and caudal terminal branches. However, in the text of this article, these latter terminal branches are referred to as the common basal and descending mammary branches respectively. This designation was adopted because of the constant course and disposition of these vessels in the udder, and not on the assumption that these vessels supplied the anterior and posterior quarters respectively. This latter view was found to be incorrect in some of the specimens examined.

1. The Common Basal Artery

In the celloidin preparation, this vessel was the larger and more important of the two terminal branches of the mammary artery. The vessel continued the course of the parent vessel along the lateral part of the base of the udder, being 1-1½ in. from the lateral border and ½ to 1 in. deep to the dorsal surface. At the junction of the cranial and middle thirds of the lateral border, the common basal artery terminated by dividing into lateral and medial basal branches.

In Part I of this study it has been mentioned that these latter basal branches were identical in their course and disposition with the terminal branches of the subcutaneous abdominal artery. In the udder, these vessels gave off several descending branches in the cranial part of the anterior quarter. The lateral basal branch represented the dorsal branch of Emmerson (subcutaneous abdominal artery) and the cranial mammary branch of Zietschmann which took origin from the cranial terminal branch of the mammary artery. The common basal artery gave off the following branches:—

A. The Lateral Artery to the Anterior Nipple

This vessel took its origin from the parent vessel before the latter terminated. It proceeded in a ventral and cranial direction to the anterior nipple,

giving during its course numerous twigs to the mass of the cranial lactiferous sinus. At the base of the latter region, the vessel terminated in several branches encircling that area and giving a picture simulating what was described as the arterial ring of Riederer (1903). From this, numerous finer branches were given to the anterior nipple (Riederer's papillary vessels). The lateral artery to the anterior nipple represented the dorsal middle branch of Emmerson, which was described as appearing on the antero-lateral aspect of the anterior nipple.

B. The Deep Mammary Artery

This vessel took origin from the parent vessel in the interval between the masses of the anterior and posterior quarters. The vessel proceeded ventrally deep into the parenchyma, forming more or less an arch, the convexity of which was cranial. On reaching a depth nearly half-way between the dorsal and ventral borders of the udder, it turned caudally and continued its course in an almost horizontal manner to the ventral part of the caudal sulcus. The vessel did not terminate in that region but seemed to be connected with the perineal artery, which came to this region as has already been mentioned in Part I of this work. The proof of this connection, in this case, could not be obtained, because in removing the udder to make the celloidin preparation, the perineal artery was cut through. Generally speaking, this vessel resembled in its distribution, but not its course, the cranial terminal mammary branch described by Zietschmann (1917). Zietschmann stated that the medial branches running to the cisterns proceeded from particular medial mammary vessels arising from the medial mammary artery of Fürstenberg (1863). It was not possible to find in the celloidin specimen an artery corresponding exactly to Zietschmann's description of the medial mammary artery of Fürstenberg. Zietschmann, however, stated that the latter artery of Fürstenberg might be developed on one side of the udder and partly represented on the other side. Concerning this point, one can state that while a special medial artery to the cisterns may be present, this may also be replaced by numerous twigs which arise from the medial side of the main lateral branches of the mammary artery. Both these possibilities were well illustrated in the celloidin specimen under consideration. From the concavity of the arch of the deep mammary artery, a large medial branch took its origin and proceeded caudally almost parallel with the retrograde portion of the parent vessel. This vessel was distributed to the dorsal and cranial part of the caudal lactiferous sinus. In Zietschmann's description, this region was supplied by medial branches arising from the caudal terminal branch of Fürstenberg's artery. At the point where the deep mammary artery turned caudally, it gave off the principal artery to the anterior nipple, which had more or less similar arrangement to the corresponding cranial artery. This vessel corresponded to the distal middle branch of Emmerson, which terminated as the papillary artery on the postero-lateral aspect of the anterior nipple. At the same point, the lateral artery to the cranial lactiferous sinus took its origin.

Slightly distal to the origin of the lateral artery to the cranial lactiferous sinus, a short but stout branch was given off between the masses of the cranial and caudal cisterns, to which it supplied branches to their caudal and cranial parts respectively. The deep mass of the cranial lactiferous sinus, however, was not provided with special medial vessels supplying its structure as was seen in the case of the caudal sinus. Here, numerous twigs arising from the lateral and principal arteries to the anterior nipple, lateral artery to the cranial lacti-

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ferous sinus, arch of the deep mammary artery, and partly from the medial vessel to the caudal lactiferous sinus, went to share in the supply of this region. In Zietschmann's description, the deep mass of the cranial lactiferous sinus was supplied by medial vessels arising from the cranial terminal branch of Fürstenberg's artery, which was not represented in this specimen. The retrograde portion of the parent vessel lay on the lateral surface of the caudal lactiferous sinus and the remaining part of the posterior quarter. It supplied these regions and gave off the principal and lateral arteries to the posterior nipple.

This retrograde portion replaced the lateral arteries to the caudal lactiferous sinus described by Zietschmann as arising from the cranial terminal mammary branch of the mammary artery.

From the previous survey of the distribution of the common basal artery, it is evident that with the exception of the caudo-dorsal part of the posterior quarter, which was supplied by the descending mammary artery, the vessel supplied practically the whole udder.

2. *The Descending Mammary Artery.*

In the celloidin preparation this vessel showed a posterior course, thereby justifying the retention of the previous designation given to it by other workers as the caudal or posterior terminal branch of the mammary artery. This picture, however, was due to rupture of this vessel close to its origin during the injection process and its subsequent fixation in that position. A certain amount of torsion is to be expected when using the celloidin method. The origin of the vessel, however, appeared to spring at almost right angles to the common basal artery. In addition, in all other specimens examined, either by dssecton or X-ray, the vessel never took a definite posterior course. In all, the artery proceeded ventrally in an almost vertical direction before it terminated into several branches. The vessel supplied the artery to the supra-mammary group of lymph nodes. The distribution of this vessel was limited to the caudo-dorsal part of the posterior quarter, and besides supplying this region, it supplied the artery to the caudal sulcus and a deep branch to the caudal part of the caudal lactiferous sinus.

Having discussed the results obtained by the celloidin injection corrosion method, the following information will deal with the findings obtained by the other methods used.

The mammary artery reached the base of the udder at a distance of ½ to 1 in. from the lateral border and 3-5 ins. from the caudal extremity. In this region, as the vessel entered the parenchyma of the organ, it was related medially to its vena comitant and the efferent lymph trunks situated between them. Caudally, the artery was in relation in most cases to the superficial supra-mammary lymph node, and cranially to the deep supra-mammary lymph node, or nodes when they were present. After a short course of 1-1½ ins. into the parenchyma the vessel terminated by dividing into two main vessels which varied in their disposition according to whether or not the subcutaneous abdominal artery was present. When this latter vessel was present as a collateral branch of the mammary artery, the mammary artery terminated by dividing into :—

1. Descending mammary branch,
2. Common basal branch.

The latter arrangement is illustrated in Photograph No. 3 and was the more common manner in which the mammary artery terminated; the description

of its distribution given here, with the variations encountered, was made in the light of the results obtained.

The Descending Mammary Artery.

This vessel left the main vessel almost at right angles to the other terminal branch and proceeded ventrally, in an almost vertical direction, to its termination. In its course the vessel was situated laterally at a depth of 1-1½ ins. from the lateral surface. It terminated at a variable distance of 3-4 ins. from the ventral border of the posterior quarter. The vessel gave off the following branches:—

1. *The Artery to the Supra-mammary group of Lymph Nodes.*

This vessel supplied the lymph nodes and the dorso-caudal part of the posterior quarter. It was seen, however, to take origin from the mammary artery itself as the latter entered the parenchyma. In two specimens an anastomotic branch was found connecting this vessel with its fellow on the opposite side—thus bringing the mammary arteries into connection with each other. Reference has already been made to this point.

2. *Parenchymal Branches.*

Several parenchymal branches were given off from both the cranial and caudal aspects of the vessel. The caudal branches ascended in a dorsal and caudal direction, supplying the dorsal and caudal part of the posterior quarter as far as the median septum and the caudal sinus respectively.

The terminal branches of the descending mammary artery were as follows:

3. *The Artery to the Caudal Sulcus.*

This vessel proceeded in a caudal and ventral direction, terminating in the ventral part of the caudal sulcus. Several ascending branches were given off from its caudal aspect which were distributed to the ventro-caudal part of the posterior quarter.

4. *Superficial Branch.*

This vessel proceeded in an opposite direction to the preceding vessel, i.e., in a cranial and ventral direction, terminating superficially at the caudal part of the inter-mammary sulcus. In other specimens examined this vessel reached the posterior nipple.

5. *Deep Branch.*

This vessel sprang either as a terminal branch (Photograph No. 1) or as a collateral branch of the parent vessel near its origin. (Photograph No. 3.) In the former case it ran ventrally and cranially deeper than the other branches, and after a short course broke up into a number of branches supplying the deep parenchyma of the posterior quarter. Before its termination the vessel, however, gave off a branch to the dorsal and caudal part of the caudal lactiferous sinus. In the latter case it proceeded directly to the dorsal part of the caudal lactiferous sinus.

The Common Basal Artery.

This vessel was the larger of the two terminal branches of the mammary artery. Its course corresponded to the course of the subcutaneous abdominal artery along the base of the udder, being situated at a deeper level. The vessel terminated at a variable distance from its origin, usually midway along the base

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of the udder and occasionally soon after its origin. (Photographs 4 and 5). Both arrangements were seen in the same udder in either artery. The deep branch of the descending mammary artery to the caudal lactiferous sinus may take origin from the common basal artery. A similar branch was given off to the cranial lactiferous sinus. This latter vessel was seen to arise from the main vessel before its termination.

After leaving the parent vessel each of these latter vessels proceeded ventrally and cranially, giving off several parenchymal branches and terminating at the dorsal part of the lactiferous sinus by dividing into several branches, supplying its structures. Other twigs contributed to the supply of the corresponding nipple.

The terminal branches of the common basal artery corresponded to the terminal branches of the subcutaneous abdominal artery when this was absent. The course of these vessels has already been described. The artery to the cranial lactiferous sinus may take its origin from the lateral basal branch instead of the common basal artery as already mentioned. (Photograph No. 3). From the caudal aaspect of the artery to the cranial lactiferous sinus, a short but strong branch sprang in a caudal direction, supplying the dorsal and cranial part of the caudal lactiferous sinus. This vessel represented the caudal terminal branch of the medial mammary artery of Fürstenberg seen arising from the arch of the deep mammary artery in the celloidin preparation.

The course of the subcutaneous abdominal artery has already been mentioned. It only needs to be mentioned that this vessel, during its course in the udder, gave off a cranial and a caudal lateral branch to the dorsal part of the corresponding lactiferous sinus. (Photograph No. 1). These vessels were seen to arise from the common basal artery, as has already been mentioned, in the absence of the subcutaneous abdominal vessel.

The Cranial Terminal Mammary Artery.

It has already been mentioned that when the subcutaneous abdominal artery was present (less common), the mammary artery terminated by dividing into descending and cranial terminal mammary branches. The latter branch extended in both quarters of the same side from its origin in the caudo-dorsal part of the posterior quarter to its termination in the ventro-caudal part of the anterior quarter. (Photograph No. 1). Thus, this vessel had no relation to the base of the udder as was the case with the common basal artery. From its above course it would be justifiable to retain this designation in full accordance with the description of other workers. The cranial terminal mammary artery gave off the following branches :—

1. *The Artery to the Caudal Lactiferous Sinus.*

This was given off a short distance from the origin of the parent vessel, proceeding cranially and ventrally to that region, terminating in the posterior nipple. At the base of the nipple the artery terminated into a cranial and caudal branch.

The cranial branch appeared superficially after emerging from the parenchyma slightly cranial to the base of the nipple, and soon divided into two to three branches which followed the medial aspect of the cranial border of the teat to its free extremity. From the size of this vessel and its distribution in the submucosa it may be considered as the principal artery of the teat. (Photograph No. 6). On the other hand the caudal branch appeared superficially on the lat-

eral aspect a short distance above the base of the nipple as the lateral artery of the teat. It soon divided into two main branches, which followed the cranial and caudal borders of the nipple to its free extremity. Several fine twigs sprang from these branches, forming a vascular network under the skin.

The artery to the caudal sinus, besides supplying the above regions, gave off several branches from its caudal aspect to the cranial part of the posterior quarter. The remaining part of this region was supplied by the descending mammary artery, which was restricted in its distribution to that region.

2. *Medial Dorsal Branch.*

This vessel sprang from the medial aspect of the parent vessel, cranial to the artery to the caudal lactiferous sinus, and proceeding immediately cranially and dorsally, was distributed to the basal part of the anterior quarter.

3. *The Artery to the Cranial Lactiferous Sinus.*

This vessel took its origin from the lateral aspect of the main vessel immediately cranial to the medial dorsal branch. Proceeding cranially and ventrally, the vessel terminated as the principal artery to the anterior nipple. The vessel, though, corresponded in its distribution to the corresponding vessel of the posterior nipple; it appeared superficially slightly caudal to its base and followed the medial aspect of the posterior border.

4. *The Lateral Artery of the Anterior Nipple.*

The vessel represented the cranial terminal branch of the parent vessel. After traversing the lateral aspect of the cranial lactiferous sinus, the vessel terminated in a similar manner to the corresponding vessel of the posterior nipple.

5. *The Medial Mammary Artery of Fürstenberg.*

This vessel arose from the main vessel between the origin of the artery to the cranial lactiferous sinus and the lateral artery to the associated nipple. In Zietschmann's description this vessel took origin from the parent vessel between the lateral arteries of the caudal lactiferous sinus. After a short, tortuous course ventrally it terminated into a cranial and a caudal branch supplying the deep mass of the caudal part of the cranial lactiferous sinus and the cranial part of the caudal lactiferous sinus respectively.

6. *Cranial Mammary Branch.*

This is the other terminal branch of the cranial terminal mammary artery, which proceeded cranially and dorsally, terminating in several branches supplying the cranial part of the anterior quarter to the cranial sulcus.

Summary

The arterial distribution in the udder was investigated in ten udders: 5 by dissection, 4 by X-ray and stereoscopic method followed by dissection, and one by the celloidin injection corrosion method. The results are as follows:—

On either side of the udder there is a great individual variation as regards the distribution of the mammary artery.

A celloidin preparation of the distribution of the mammary artery presented a different picture from what has been described by other workers. The description and discussion of this preparation have been elaborated in detail.

There is evidence that in some udders both mammary arteries may be connected together.

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The results obtained indicate the absence of anastomotic connections between the main vessels of the terminal branches of the mammary artery.

There is no evidence of interconnection between the small branches of the main vessels of either one or both quarters of the same side.

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CHEMOTHERAPY IN THE TREATMENT OF CHRONIC CONTAGIOUS MASTITIS

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THE serious loss that is incurred annually by dairy farmers due to the ravages of mastitis has long been recognised. It is universally agreed that whilst other forms are of importance, that type of mastitis associated with *Streptococcus agalactiæ* and termed chronic contagious mastitis is responsible for the greatest financial loss. Stableforth (1938, 1939) considered that mastitis in Great Britain cost the farmer between £1-2,000,000 annually, and more recent estimates put this as being nearer £5,000,000. Chronic contagious mastitis occurs in almost every country in Europe and has been reported as widespread in North America and Australasia. It is not surprising, therefore, that much research has been undertaken in an endeavour to find a method of combating this disease. Preventive control measures can be very effective but require as an adjunct some form of treatment in order to sterilise udders which are harbouring the causal organism. There is urgent need of a cure which should by preference not only bring about a clinical response but should kill all causal organisms as well. Several other conditions (e.g., little interference with milk yield) also have to be fulfilled.

The search for such a line of treatment has been going on for years, and many products have been tried. The literature published prior to 1934 is of limited value, because before then the bacteriology of mastitis had not been worked out. Even some quite recent publications do not offer categorical evidence that the mastitis under treatment was caused by *strept. agalactiæ.*

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Bibliography

Amongst the earliest work on chemotherapy in mastitis was that of Bugge (1923), who reported on the treatment of a few cases by rivanol, a substance which was later to receive much attention, and Schnorf (1925) reported experimental work on a number of acridine dyes, including rivanol and a derivative of this—uberasan. These fell into disfavour, however, until Steck (1931) called attention to their value, his work being confirmed by Gotze (1931), who used entozon. Seelemann (1932) experimented with rivanol and entozon, and in conjunction with Siemonsen (1933) he compared numerous other acridine derivatives and several inorganic compounds, but concluded that for the least irritant action and highest bactericidal effect entozon and rivanol were the most effective. Hunter and Lee (1932) tried azamine, a pyridine derivative, with fairly satisfactory results. Steck (1934), summarising the knowledge as it then existed, discussed experiments with uberasan, rivanol lactate, rivanol chloride, trypaflavine and entozon, and emphasised that as yet the number of field experiments was not sufficient to allow one to be dogmatic. He preferred trypaflavine in chronic and subacute cases and entozon in acute cases, recommended using 1 : 4,000 to 1 : 2,000 dilutions of trypaflavine and 1 : 1,250 for entozon, and advocated that a small quantity (*circa* 100-200 c.c.) be first introduced into the teat canal to rinse the lower part of the cistern. This was immediately stripped out and the quarter was then filled to roughly milking tension. A great deal of field work appears to have been undertaken about this time, and in 1936 several reports on such treatment appear. Steck (1936) reported success in the control of streptococcal mastitis in eight herds by infusion of infected udders with acridine compounds. He stated that "the best method of treatment available for streptococcal mastitis is udder infusion." He advocated the use of trypaflavine by the technique of using a weak first injection followed by a stronger one. He considered the addition of saccharose to the solution to be beneficial. These two substances are contained in a preparation called "zysteral," and by the use of this Steck claimed the successful treatment of 75 per cent. of infected quarters. Karlson and Ridale (1936) reported that in two herds 69 out of 92 quarters treated with entozon were freed from infection, as also were five out of 11 quarters treated with trypaflavine. In most cases the organism disappeared from the milk after one or two injections, and the optimum period for treatment was during the latter half of lactation or whilst dry. Posgay (1936) used entozon (1 : 1,750) solution in the treatment of 19 artificially infected and nine naturally infected quarters. He obtained temporary sterilisation for five to six days, but a complete permanent cure was only effected in 14 quarters (56 per cent.). Wolf and Leskien (1936, 1937) used trypaflavine (by Steck's technique) for the treatment of 36 quarters; 25 (69 per cent.) were freed from infection and remained so for three months. Lew (1937) reported on the use of 0.1 per cent. rinavol solution by udder infusion, and the conclusion to be drawn is that many cases were freed from infection, though not all treatment resulted in a full recovery of secretory function. Helm (1937), however, reported that the infusion of 33 dry cows with entozon only cleared infection from two animals. A fresh substance appears in literature, a product called "Weidnerit" or argento-weidnerit. Schmidt and Hoernsdorf (1937) used 50-100 ml. of argento-weidnerit (probably silver-sulphocynate) and claimed a high percentage of cures. He described the preparation as non-irritant and stated that it could be given to lactating and dry cows. Schmidt

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(1937) treated 33 infected cows with argento-weidnerit and stated that 29 quarters out of 22 cows responded to treatment, while 26 quarters of 11 cows showed no appreciable change. The optimum time for treatment appeared to be when the cows were in full milk. Wolf and Leskien (1937), using weidnerit, stated that it had no effect on streptococcal infection. Seelemann and Siemonsen (1939) stated that they had not found argento-weidnerit to be of value and could not recommend this drug for the treatment of mastitis.

Another substance called "Mastite" received attention. The composition of this product is not disclosed completely, but is stated as containing "immune bodies specific for mastitis streptococci, Besredka's antivirus against streptococci and a stimulant." Using 100 c.c. of this preparation, Hill (1937) came to the conclusion that mastite was of no value. Seelemann and Siemonsen (1938) found that different batches of mastite varied in effect and could not confirm its value. Klimmer and Haupt (1938) reported on a herd of 60 milking cows with an original infection of 70 per cent. of the animals. In three years 102 cows were examined and 857 quarters were taken. They treated 254 lactating quarters (31.5 per cent. cures—10.7 per cent. probable cures) and 66 quarters of dry cows (47.3 per cent. cures and 33.7 per cent. probable cures). In addition, 16 quarters recovered spontaneously. Seelemann and Siemonsen (1938b) tried trypaflavine infusion in 12 lactating and seven dry cows, but concluded that they preferred entozon. Steck (1938) pointed out that this was probably due to faulty technique, as he had found trypaflavine to be 75 per cent. effective. Giebner (1938), using *in vitro* tests, showed that trypaflavine was more potent in comparable solution than entozon, and that rivanol took third place. Stableforth and Scorgie (1938) reported on the use of entozon and acriflavine (an English preparation stated to be equivalent to trypaflavine). They found that, using entozon, nine experimental infections were all cured with one or two treatments (five-minute infusions); 29 out of 46 quarters of latently infected lactating cows, 10 out of 13 quarters of latently infected dry cows and 13 out of 37 quarters of clinically infected cows were also cured. Using acriflavine, 26 out of 29 latent and nine out of 12 clinical cases were cured. Using the method advocated by Steck in 1936, they tried the effect of 1 : 1,000 acriflavine solution following a previous injection of 10,000. This resulted in permanent damage to five out of seven quarters. Abbott (1938), Bryant (1938) and Ramsay (1938) all claimed good results from the use of sulphanilamide, the dosages ranging from 5-15 grms. per 100 lb. bodyweight. Geldow *et al.* (1938) showed that the drug did not permanently sterilise udders that were infected. Johnson and Miller (1938) could not obtain any beneficial effect from the use of sulphanilamide in 10 cases of mastitis; evidence is not given to show that the casual organism was, in all cases, *strept. agalactiæ*. Bauer and Gunderson (1938) treated eight cows with doses varying from ½-16 oz., but found that the streptococci in the milk were only held in abeyance as long as the drug could be detected in the milk. Little (1939) administered sulphanilamide to five cows suffering from streptococcal mastitis and found that although symptoms were alleviated the causal organism still remained in the udder. Stevenson (1939) treated 10 cows and found that the organisms excreted in the milk were not affected. Erf (1939), presumably working on Jersey cows, administered sulphanilamide to a large number of animals suffering from mastitis and found that symptoms were alleviated, but that the organisms reappeared three to four weeks after dosage had ceased. A further course, however, usually sufficed to

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clear the animals of infection. He aimed at maintaining a concentration of 5.4 mgm. in the blood. Miller *et al.* (1939) and Gildow with his associates (1939) were unable to sterilise infected quarters, although the latter workers noticed an improvement in clinical cases. Veenbaas and Sjallerna (1939) compared the value of sulphanilamide, prontosilsoluble and orgasepton (a Dutch product akin to sulphonamide) per os and udder infusions using entozon, trypaflavine and orgasepton. They found no beneficial effect from the substances per os and preferred entozon for infusion. Seelemann and Watzler (1939) found that two new modifications of entozon (entozon A and B) were inferior therapeutically to the original substance. Gerstner (1939), using varying concentrations of trypaflavine and entozon, claimed the successful treatment of 74 out of 76 infected quarters. Andres (1939) recorded the use of Kapff's acid gas method of treating mastitis. This technique is based on a therapy first introduced in 1909 and necessitates the use of a proprietary mixture which includes organic and inorganic acids. Andres claims the curing of 60 per cent. of 50 cows, 8 per cent. improvements and 32 per cent. not affected. No specific mention is made of the nature of the causal organism. Schalm (1940) infused udders with entozon every 7-14 days until *strept. agalactiæ* could no longer be demonstrated in the milk, and claimed a 90 per cent. success. Stewart (1940) obtained a 70 per cent. success by three treatments, but only observed his cases for a fortnight after final treatment. Schoepe (1940) records the use of flavisill, a proprietary acridine dye, to which is added a local anæsthetic. He obtained bacteriological cures by the single treatment of 25 out of 32 quarters affected with *strept. agalactiæ*, whilst five quarters cleared up after two treatments. Milk yields were not affected. Bryan and Arnold (1940) gave large doses of sulphanilamide to cows, but were unable to eliminate the streptococcus. Little (1940a and b), with his associates, called attention to the use of gramicidin (an alcohol soluble substance isolated from cultures of a sporulating soil bacillus). Using solutions of 6.2 per cent. in distilled water, they had little success in the treatment of two cows with marked induration of the udder; but in the case of nine quarters of three cows showing only moderate induration, six responded to one treatment, one to five repeated injections, and two quarters did not respond at all. The same experimenters (1941a) evolved the technique described later in this article and used it to eliminate *streptococcus agalactiæ* from 21 (65 per cent.) infected quarters; 11 required only one infusion, the remaining 10 being treated repeatedly. Later (1941b), they sterilised 23 of 28 infected quarters by the use of gramicidin. They also describe the use of novoxil (a silver oxide in oil preparation) and indicate that of 17 quarters treated, 58 per cent. were cured bacteriologically in one series of experiments, whilst five of 10 quarters were successfully treated in another series. Wierether *et al.* (1941) treated one quarter each of three cows infected in all quarters with novoxil, and these former remained clear of infection for 11-37 days (no precautions were taken to prevent reinfection). Klein and his associates (1941) recommended 3-5 injections at 24 hours interval and, using novoxil in this scale of dosage, freed 59 of 67 quarters from infection. McEwen, Pryer and Paterson (1941) mentioned the use of sulphanilamide E.O.S. and 4: diaminodiphenylsulphone per os; neither drug appeared to be efficacious in removing *S. agalactiæ* from the udder. Johnson (1941) reported that by using acriflavine in a strength of 1 : 4,000 (later changed to 1 : 8,000) he cleared 164 cases (69.1 per cent.) of *strept. agalactiæ* and raised this figure to 204 (86.1 per cent.) by repeated infusions.

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Schalm (1941), using a 1 : 1,500 sol. trypaflavine in 20 per cent. sucrose for five minutes, obtained 65 per cent. cures with one treatment and 93 per cent. with two infusions. There was little reduction in milk yield. Later Schalm 1942) compared the results of various types of udder infusion and placed them in the following order of merit: entozon (1 : 1,250), gramicidin, novoxil, acriflavine and sucrose (1 : 1,500) and acriflavine (1 : 10,000). Tripp and Lawrence (1942), using gramicidin to treat mastitis in Friesian and Channel Islands cattle, reported that of 18 quarters in which *streptococcus agalactiæ* had been demonstrated prior to treatment, the causal organism was removed in 16 cases. In a further four cases in which suitable milk samples were not forthcoming, three clinical cures were registered. Sanders (1942) reported favourably on the use of a 1 : 1,000 to 1 : 1,500 solution of resublimed iodine in mineral oil; the action seems to be similar to that of novoxil. A useful summary of work carried out in England using sulphanilamide per os and to a less extent euflavine in 5 per cent. lactose solution via the teat canal is given by Stableforth *et al.* (1942). After discussing a number of experiments to establish the best scheme of dosing with sulphanilamide figures are given to show that out of 299 cows in which the initial dose was 1 gr. per 5 lb. bodyweight, followed every eight hours by 1 gr. for every 30 lb. bodyweight, for seven days, 34.8 per cent. were bacteriologically cured and 55.2 per cent. clinically cured.

Palmer (1942) used a sulphanilamide in oil suspension but did not record the results, whilst Sanders (1943), using sulphanilamide in iodised mineral oil, successfully treated 90 per cent. of 50 lactating cows. Guard (1942) was the first to emphasise the surgical necessity for resting the quarter and advised drying up affected quarters. Bryan *et al.* (1944), using tyrothricin, claimed to have cleared of infection 90 per cent. of 157 cows.

Andberg and Weirether (1943) found that novoxil caused some damage to normal lactating udders but had less effect on dry cows. The value of novoxil, tyrothricin, acriflavine and entozon was compared by Bean *et al.* (1943), mastitis due to various organisms being treated. Both dry and lactating cows were treated, and while summary of the results is difficult, tyrothricin gave the best results in dry cows (92 per cent. of 51 quarters were cleared of infection) and the worst (51 per cent.) when used in lactating animals. They called attention to the fact that response to treatment varied inversely with the amount of fibrous tissue present, a point emphasised by Udall *et al.* (1943).

Johnson (1944) gave an extensive account of the use of acriflavine in dilutions varying from 1 : 4,000 to 1 : 8,000 (dissolved in some cases in 10 or 20 per cent. dextrose) in the treatment of dry and lactating cows suffering from mastitis due to a variety of organisms. His results show a lower percentage of recoveries than Bean *et al.* He also records the use of novoxil (average 75 per cent. recoveries in dry and lactating cows), tyrothricin (45 per cent. bact. recoveries and 67 per cent. clinical responses for dry cows—lactating cows responding better) and sulphanilamide in oil (less response to this drug). He did not confine his treatments to streptococcal mastitis, nor did Roberts, who, dividing his cases on clinical grounds, used acriflavine (1 : 6,000), tyrothricin and sulphanilamide in oil. His best results were obtained from the last-named product.

Observations

It will be seen from the above summary that many workers have arrived at varying conclusions, although the technique employed and the drugs used are

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apparently the same in a number of cases. The number of cases treated may sometimes appear small. This is probably due to the difficulties attending the selection of suitable cases.

Ideally, one should first establish, by means of repeated cultural examinations, which is the causal organism. Subsequent examinations must be carried out periodically after treatment, and during this period the animal must be safeguarded from the danger of reinfection. This is most easily done in herds under mastitis control, but in such herds the incidence of clinical mastitis is usually low. In some countries research and teaching institutions run ambulatory clinics, but in Britain the majority of the cases are treated through the courtesy of the veterinary practitioner. This scheme is attended by several difficulties. In the first place the client naturally expects some treatment to be carried out immediately, and he cannot be asked to wait whilst repeated bacteriological examinations of the milk are carried out; moreover, once a series of successful treatments has been completed on any one farm, the stock owner is naturally not keen on some other form of therapy, the efficacy of which may be in doubt, being used instead. Random visits to farms also have the disadvantage that no guarantee can be given that some treatment has not already been carried out by the herdsman or that the case is only of recent onset. It is therefore necessary to pick carefully the farms on which research treatment is carried out.

A second difficulty is the wastage incurred (up to 25 per cent. of all treated cows) through the sale of treated cows before an adequate number of observations can be made; this is especially the case with dry cattle and particularly so in war time, when any breed of cow has a potential beef value. We have learnt, too, to mistrust the herdsman's identification of beasts unless they are ear or horn marked.

We have not carried out any work on the treatment of latent mastitis in lactating cows, as it was felt that the loss of even a few gallons of usable milk was, in war time, to be deprecated.

A number of the above difficulties can be overcome by the use of purely experimental farm herds, but even so the experimenter has to bear in mind three important points:—

(1) *Breed.*—Early investigators paid little attention to this point, but it is becoming increasingly obvious that the matter should not be overlooked. A considerable number of the cows used in the early therapeutical trials in this country were of the Channel Islands breed. It is now apparent that these animals respond very well to treatment. Later, considerable work was done in the North of England and in Scotland, where the Ayrshire predominates; it would seem that this breed does not respond so well to treatment and consequently the figures obtained were disappointing, in view of the early promise. It is the authors' opinion that the Shorthorn occupies a place midway between these breeds, whilst the Friesian is as difficult as the Ayrshire to treat successfully.

(2) *Strain of the infecting streptococcus.*—The authors have noticed during routine herd tests that not all the strains of *strept. agalactiæ* isolated behave similarly. Slight differences are apparent with regard to the appearance of the colony on blood agar, growth in glucose broth, reaction to the precipitin tests, etc., etc. The behaviour of the organism is usually constant throughout any one herd. The clinical picture presented by each herd also varies slightly in such matters as appearance of the milk, feel of the udder, virulence and ease

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of spread. For this reason the authors recommend the use of the phrase "herd variants." Stableforth and his co-workers stress this point and call attention to the fact that Long and Bliss (1939) and Heishmann and Miller (1940) have reported similar variations. It is not surprising therefore that the effect of any therapeutic substance will not be the same when used in different herds, even when such herds are composed of animals of the same breed under similar conditions of management. We found, for instance, that sulphanilamide used on one farm was of value, whilst on another farm, on the same estate, situated within two miles, the drug had little effect.

(3) *Skill of the milking attendants.*—Since some attendants are particularly successful in the care of sick animals, the important bearing that this factor can have on results must be borne in mind.

For these reasons it is essential that when an attempt is being made to assess the value of a substance for the treatment of mastitis, all types of herds and breeds, in different parts of the country, should be used as experimental material.

(*To be continued*)

Clinical Article

AN AIR-RAID INJURY

By R. A. EDWARDS, M.R.C.V.S., and W. B. CONN, M.R.C.V.S.,
Rochester, Kent

Subject: A white fox terrier puppy, aged six months.

History: The owner informed us that ten days previously a V.2 had fallen close to her house, partly demolishing it. The dog and her little son were trapped by the debris. The boy sustained two broken legs, but the dog apparently suffered no harm. Two days before we saw the animal the owner noticed acceleration of the breathing, and on this becoming exaggerated she brought the dog to us.

Symptoms: The most outstanding symptom was respiratory embarrassment. Respiratory movement was mainly abdominal. The temperature was normal, and the visible mucous membranes pale and anæmic. Heart sounds were dulled and auscultation of the chest revealed no respiratory sounds.

Diagnosis: Rupture of the diaphragm.

Prognosis: Hopeless. Actually the dog died a few minutes after the examination was finished.

Post-mortem: Lesions were mainly confined to the thoracic cavity.

Lungs: Nearly collapsed and solid except for very small areas. The chest cavity was full of blood-stained serum. The diaphragm had a rupture about 1½ in. in diameter situated on the left side in the muscular portion. Protruding through the rupture was about a foot of small intestine, also the left central portion of the liver, which was congested. The abdominal cavity contained some fluid.

Discussion: The ruptured diaphragm had a well-defined periphery of fibrous tissue, which suggested that the rupture might have been there for some considerable time and, being small, did not cause any harm, but as a result of blast and/or direct pressure, the organs were forced through and so the opening was enlarged.

This case is recorded on account of the scarcity of records on the subject of air-raid casualties.

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Abstracts of Current Literature

HOG CHOLERA IN THE UNITED STATES*

Hog cholera (swine fever) continues to be the most serious disease of American livestock. It kills more animals and destroys more food poundage than any other disease, yet little concerted effort is being made to stamp it out, because the vast swine population can be maintained by practising serum-virus vaccination on a large scale throughout the swine-breeding areas of the Middle West. But the cost is a tremendous one to the farmers concerned. A vast serum-producing industry, operated under close government supervision, and employing large forces of laboratory technicians and field men (federal, state and commercial) has to be maintained. The time is felt to be approaching when the farmers of the Middle West will demand that a program of eradication be instituted. As long as only veterinarians were permitted to use the vaccinal virus, cholera was fairly well mastered, but after laymen were allowed to vaccinate their own hogs, more and more territory became infective. Untutored farmers are not always able to differentiate cholera from clinically similar diseases—swine erysipelas and virulent enteritides—and thus complicate the swine disease problem and suffer losses by mistaking these for cholera. Faced with the rich benefits derived from the eradication of bovine tuberculosis, tick fever and the gains made in proper handling of brucellosis and pullorum disease of poultry, the American swine breeder is beginning to question the present hog-cholera situation.

* *Journal of the American Veterinary Medical Association,* August, 1944.

PHYSIOLOGY OF MAMMARY DEVELOPMENT†

In both the process of development and functioning the mechanism of lactation is under the command of the endocrine system. The two ovarian hormones, estrogen and progesterone, cause the growth of the lobules, ducts and alveoli, although in some species, perhaps including the cow, estrogen alone is capable of producing complete development. The extent to which the hypophysis participates in mammaryogenesis is controversial. The accelerated growth of a mammary gland brought about by topical applications of estrogen to a developing mammary gland is pointed out as evidence that the ovarian hormones are not dependent upon the pituitary hormones but that, on the contrary, they act upon the hypophysis to produce the mammaryogenic stimuli. Pituitary hormones, however, are necessary to the complete development and functioning of the mammary gland, acting through the intermediary of the thyroid and adrenals, each having regulatory roles. Critical studies reveal that all the hormones concerned in the well-being of the animal economy contribute to mammary growth. The interaction is complicated, involving the pituitary, thyroid, adrenal, ovarian, luteal and placental hormones. In the cow, the synthetic estrogen, stilbœstrol, not only causes complete mammary development but also starts lactation in sterile heifers even to the probability of producing satisfactory milk production. Its action in the multiparous cow is less pronounced, but the reason for the difference is not known.

† *Proceedings, Indiana Veterinary Medical Association,* January, 1944.

PRODUCTION OF WHOLESOME MILK‡

As a measure for producing wholesome milk, superior inspection is rated higher than counting bacteria. The value and safety of milk for the human

‡ *Journal of the American Veterinary Medical Association,* August, 1944.

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dietary depends upon production, processing and distribution practices. The objective should be increased consumption, fair returns for the dairy farmer, and official supervision that does not materially advance the retail price. The importance of pasteurisation should be stressed. Holding milk at a temperature of 145 deg. to 150 deg. F. (63 deg. to 66 deg. C.) for 30 minutes is the minimum requirement for safety, and is preferable to the "flash" of 162 deg. F. (72 deg. C.) for 15 seconds, which damages the food value of milk so treated. "In-bottle" pasteurisation gives excellent results, provided the bottles are previously sterilised, and it can be done at lower cost.

Obituary

JOSEPH B. DIER

JOSEPH B. DIER died on January 13, 1945, after a long illness. He qualified in 1889, and had been in practice in Sussex for over 50 years.

Mr. Dier was a most competent veterinary surgeon and a great gentleman, and he earned the respect and esteem of his colleagues and of the people in his district. By his life and work he brought great credit to his profession, and we have great pleasure in printing the following tribute from the pen of one of his professional neighbours.

"Few recently qualified veterinary surgeons can visualise the complete activities of the late Joseph Dier.

"Taking his diploma at the London College in the far-off days of 1889, when the various drugs and injections now used every day by practitioners were unknown, he gave the whole of his life and energy to the welfare of the animals entrusted to his charge.

"Efficient and respected from the earliest days of his entering country practice, as the years passed by he became the true friend and adviser of the landowners and farmers in the wide district where he practised so successfully.

"It is easy for a young man enjoying robust health to go out every day in all weathers to attend to animals on farms, but for a man suffering from ill-health to continue what he considers a duty, in spite of pain and weakness, shows an heroic character which places first the calls of his profession.

"Our profession is fortunate in having many men who devote their lives to their calling, but among them all are few with such a record of achievement and valuable work.

"Never perturbed by any circumstance or difficulty, he set an example to all those who intend proving to the world the value of the services of the ordinary unnoticed, modest veterinary surgeon.

"Such men have built up for all newcomers a standard which, if followed, will lead the profession forward until full recognition is given, by even the unheeding, to the value of qualified veterinary practitioners.

"If ever a man carried out the highest self-sacrifice involved in unceasing life devotion to a profession, that man was the late Joseph Dier."

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